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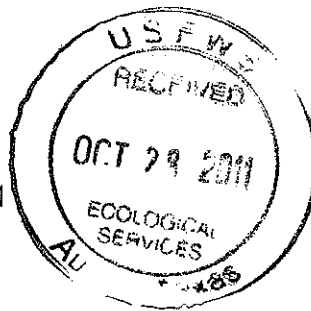
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October 18, 2011



Ms. Alisa Shull
U.S. Fish and Wildlife Service
Austin Ecological Services Field Office
10711 Burnet Rd., Suite 200
Austin, TX 78758

Dear Ms. Shull:

Texas Parks and Wildlife Department (TPWD) is providing this information in response to the U.S. Fish and Wildlife Service (USFWS) request for information and data related to the status of and threats to the Salado salamander (*Eurycea chisholmensis*), Georgetown salamander (*E. naufragia*), Jollyville Plateau salamander (*E. tonkawae*), and Austin blind salamander (*E. waterlooensis*). TPWD appreciates the opportunity to provide any information and assistance that will aid in the protection and management of Texas' species. As always, we at TPWD strongly encourage the use of incentive-based conservation programs that consider the important role private land stewardship plays in wildlife conservation in Texas. The use of such programs can often achieve necessary goals for species while avoiding regulatory burdens of listing.

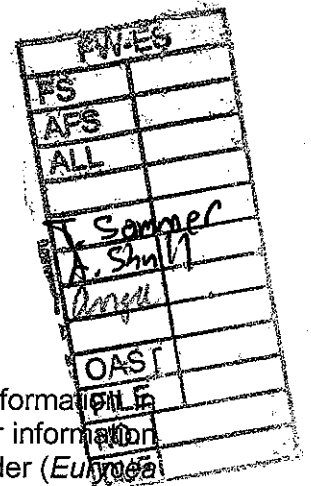
The four *Eurycea* salamander species addressed in this response have limited, isolated, and specialized geographic distributions (Figure 1). Impacts to surface and groundwater resources in areas where salamanders occur directly influence their status. Where population studies have allowed estimation of population size, estimates are low — a few dozen to a few hundred individuals per population.

This document provides a brief summary of the geographic distribution, population status, threats, regulatory mechanisms and special management considerations for each species. Particular emphasis is given to the Salado salamander in this treatment because of the paucity of published information available for this species. Many of the general habitat descriptions, threats, issues, and management considerations presented for the Salado salamander can also be generally applied to the other three *Eurycea* species in this document. Enclosures with this letter include citations, maps showing each salamander's distribution, and descriptions of several springs within the Salado Springs complex (Appendix A).

Salado Salamander (*Eurycea chisholmensis*)

Distribution, Abundance, and Density, including Survey Information

The Salado salamander (*Eurycea chisholmensis*) was formally described by Chippindale et al. (2000) based on material from Big Boiling Spring (aka Salado Spring) and Robertson Spring, in Salado, Bell County, Texas. A single juvenile specimen was collected by B.C. Brown from the Eastern outlet of the Lazy Days Fish Farm (immediately downstream of Big Boiling Spring) approximately



50 years prior to description of the species. Anecdotal evidence exists for populations in springs along Buttermilk Creek (G. Longley, pers. comm. to Andy Gluesenkamp, 2009) but no specimens were collected and this report has not been confirmed. It is possible that the springs in question are actually on an upper branch of Salado Creek. Survey efforts elsewhere in the Salado Creek drainage and at nearby Tahuaya Spring have been limited and unsuccessful. Intensive search efforts at the type locality between 1989 and 1991 resulted in the collection of 10 specimens and, despite more than 20 visits to the type locality between 1991 and 1998, only a single additional specimen (the holotype) was collected.

Survey efforts at the type locality and at Robertson Spring were sporadic, at best, until renewed efforts by Corey Roelke resulted in the collection of eight additional specimens during 14 visits between 2006 and 2007 (an additional two specimens were observed but not collected). A single specimen was collected and released at the type locality by a swimmer in 2009. Bottle traps were deployed and visual surveys were conducted in Stagecoach Inn Cave. The cave is a human-modified cave with a water well that intersects a conduit believed to feed Little Bubby Spring. Surveys were conducted during 2009-2011 but no salamanders were observed. Additional outlets within the Salado Springs complex were surveyed sporadically and no additional salamanders were encountered. Detailed descriptions of each of these outlets can be found in Appendix A. TPWD (Andy Gluesenkamp) surveyed known localities and other springs in the Salado Creek watershed 18 times between June, 2009 and December 2010. Populations were also found in springs that drain the elevated Edwards limestones in the upper Salado Creek Basin. The Edwards in the upper part of the basin forms an unconfined aquifer that produces gravity-fed springs, as opposed to the artesian springs produced by the Northern Edwards (BFZ) Aquifer. TPWD collected three specimens from a spring along upper Salado Creek on 11 August, 2009 and an additional eleven specimens from the same locality on 25 March, 2010. Specimens were collected from two other nearby springs: Cistern Spring (six) and Hog Hollow Spring (one) on 25 March, 2010. Single specimens were collected from Robertson Spring on 25 February, 4 March, and 24 March, 2010. A single specimen was collected from Big Boiling Spring on 30 April, 2010. All specimens collected at Robertson and Big Boiling springs were sent live to the Dallas Zoo after tail tips were collected for genetic analysis. These join five specimens collected by C. Roelke as part of a captive breeding effort. All other specimens collected were tissue, vouchered, and deposited in the Amphibian and Reptile Diversity Center at the University of Texas at Arlington. Figure 2 contains a map showing the generalized range of *E. chisholmensis*.

This species has only been found in springs emanating from Edwards limestone on the southern side of the Salado Creek watershed. It is likely that the source of water in these springs is to the South in Williamson County. Salamanders have been collected at Cobb Spring, just across the groundwater divide between Salado Creek and Berry Creek. These specimens appear to be *E. naufragia* but their genetic identity has not yet been analyzed. Despite the recent discovery of three populations in the upper portion of the Salado Creek

watershed, the range of this species remains highly restricted and populations appear to be extremely small in most cases. No hypogean populations are known although it is likely that this species relies heavily on subterranean habitat, especially in times of drought.

The Salado salamander, like other *Eurycea* species, has a highly restricted range and relatively small population sizes. Individuals are restricted to suitable subterranean habitats and areas adjacent to spring outflows. On the surface, *Eurycea* occupy a very small geographical area, rarely found more than 20 meters from a spring source. Little is known about the subterranean habitat use by *Eurycea* species and what role these habitats play in their life history; however, observations indicate that these species are only known from clear springs with high water quality and a clean gravel substrate.

Habitat Description and Requirements

Salado Springs is recognized as one of the Major and Historical Springs of Texas (Brune 1975) and is listed as the twelfth largest spring system in the state based on an average discharge of 16.2 cubic feet per second (cfs) or 10.5 million gallons per day (mgd) (Brune 1981). Composed of several groups of springs that issue from the Balcones Fault Zone of the Northern Edwards Aquifer in Central Texas (Figure 1), Salado Springs have been historically significant — a concentration area for paleo-indian cultures, historic settlement and contemporary activities (Brune 1981, Handbook of Texas Online, Texas State Historical Commission. Currently, Salado Springs and Creek serve as a major aesthetic attraction for the Village of Salado's tourist driven economy. There are two public parks along the creek; one located at the main Salado Springs (Big Boiling or Sirena Springs) on the south side of the creek and the other a short distance downstream on the north bank of the creek. Several businesses also lie along the banks of Salado Creek.

The Salado Springs complex supplies the baseflow that sustain the lower portion of Salado Creek and provide habitat for, among other unique aquatic animals, the Salado salamander. The springs have reportedly never ceased to flow, even during the drought of record (Brune 1981; USGS 2011). Because of their persistent discharge, the springs have played an important role in sustaining the ecology of Salado Creek, including instream and riparian habitats. Despite the historically reliable discharge and documented presence of rare species at Salado Springs, no extensive biological or hydrological data exists.

The Salado salamander is found in springs that issue from the unconfined Edwards limestones in the upper part of the Salado Creek Basin as well as springs issuing from the Northern Edwards (BFZ) Aquifer in the lower part of the basin. The two aquifers have different recharge and contributing zones, which greatly complicates efforts to protect and conserve the "source area" of the springs that sustain the Salado salamander.

In general, the smaller headwater springs that drain the unconfined aquifer are found on private lands. These springs are often small in terms of the volume of water produced, yet they are remarkably reliable. Because the springs generally sit high in the landscape, they likely have limited recharge and contributing zones that may be contained entirely on one property. This highlights the importance of working with and providing assistance to landowners willing to protect and conserve the springs these salamanders inhabit in the upper part of the Salado Creek Basin.

The upper portion of the Salado Creek Basin flows intermittently through the year in response to precipitation events. Streamflow in the upper portion of the creek flows eastward toward Jarrell before turning northeast toward Salado. Before turning to the northeast, Salado Creek crosses the Balcones Fault Zone resulting in an extensive section that loses streamflow and recharges the Northern Edwards (BFZ) Aquifer.

Dahl (1990) identifies specific fault locations that provide recharge to the aquifer, but also indicated that recharge of precipitation in the Salado Creek basin contributes much larger volumes of water to the aquifer (about 29,000 acre-feet in 1985) than storm runoff (about 2,700 acre-feet). This suggests that karst features on the landscape play a more important role than storm runoff in recharging the aquifer. However, it is important to note that several tributaries that feed Salado Creek and likely contain recharge features were not included in the analysis by Dahl (1990). More site specific studies will be needed to identify the significant recharge and contributing zones for the various springs inhabited by the Salado salamander.

Threats and Issues

There are numerous threats to this salamander and its habitat, including increased groundwater use, increased urbanization (i.e., impervious cover, wastewater, non-point source runoff) in recharge and contributing zones, contamination, and poor watershed management practices (i.e., disturbance of riparian zones, livestock impacts, gravel and limestone mining, and ongoing disturbance of surface habitat at the type locality). Specific threats at the type locality include pumping water from the spring opening, large-scale re-landscaping and riparian vegetation removal, contouring of the spring environs (which obliterates transient spring openings), and use of heavy machinery to cover the orifice and spring pool of Big Boiling Spring with gravel from adjacent Salado Creek. These activities continue at the time of this writing (Jim Giocomo, pers. comm. to Andy Gluesenkamp on 7 October, 2011). In addition, increased urbanization both locally and throughout the Northern Segment of the Edwards Aquifer poses a potential threat to this species. Although urbanization and residential development in the upstream portion of the Salado Creek watershed are not prevalent at this time, gravel mining and quarry operations in this area may contribute to environmental degradation of the surfacewater and subterranean retreats. In addition, small population sizes and a restricted range make this species particularly susceptible to extinction. Many of these threats are related to population growth which influences water quality runoff

and groundwater extraction that is occurring over the Northern Balcones Faults Zone Aquifer, which is the source of Salado Springs.

Municipalities (Georgetown, Pflugerville, Round Rock, Salado) and other population centers use groundwater from the Northern Edwards Aquifer. Rapid population growth documented and projected in these and adjacent developing areas (Texas State Data Center 2011) has resulted in an increase in demand for groundwater from the Northern Edwards (BFZ) Aquifer. Groundwater withdrawal reduces groundwater storage, capacity and character of the subterranean geography and reduction in natural discharge (i.e., springflows) and recharge. The ability of the Salado salamander to exploit subterranean habitats (as during the 2009-2010 season, when Robertson Springs were dry and then salamanders reappeared when flow resumed) suggests the population as a whole would be able survive a drought of record as long as the springs continued to flow, but it is likely some individuals would be lost from surface water habitats. It is unclear how long-term reduced groundwater and spring flow could affect *Eurycea* sp. directly or indirectly.

Increased groundwater withdrawals can influence the movement of the "bad water" (saline) line in the downdip portion of the aquifer, currently located about 5 kilometers east of Salado Springs (Jones 2003). As groundwater levels decline, hydrostatic pressure is decreased and the likelihood of saline water encroachment increases (Pavlicek et al. 1987). The lowering of water quality due to saline encroachment has been documented for the Barton Springs segment of the Edwards Aquifer (Slade et al. 1986); similarly, the encroachment of saline water in the Northern Edwards (BFZ) Aquifer would threaten the biota of freshwater springs issuing from the aquifer.

Studies indicate that development, intensive agricultural, and industrial activities within the recharge and contributing zone of an aquifer (e.g., impervious cover increase, native vegetation reduction especially in riparian areas, overgrazing and surface soil erosion, livestock in stream and spring sources, contaminants in surface runoff, hazardous persistent and mobile organic compounds used in agriculture and industry, sand and gravel mining) can greatly affect the quantity and quality of water into the aquifer and emanating from a spring (Holmes 2000; Notenboom et al 1994, Cherry 1987). This makes groundwater environments, their associated surface water habitats, and the biotic communities they support vulnerable and difficult to rehabilitate (van der Kamp 1995). Further complicating matters is the fact that routine water quality tests are not likely to detect many organic compounds, and the suite of tests required for their detection are sophisticated and expensive (Cherry 1987). The specific effects of contaminants on the Salado salamander is not known, but many aquatic invertebrates are known to be affected by contaminants (Notenboom et al. 1994; Rosenberg and Resh 1996). The area immediately surrounding springs is often limited in the diversity of aquatic macroinvertebrates, but commonly includes amphipods, damselflies, mayflies, snails, and flatworms, among others. Amphipods are often the dominant macroinvertebrate species found adjacent to springs and are documented as a primary food source for *Eurycea* salamanders (Petranka 1998).

The Salado Creek watershed has received at least three large rainstorm events in the past two years that have resulted in material (cobble, gravel, sand and silt) deposition. At least three times in the last three years, the Village of Salado has filled in the main Salado Spring (i.e., Sirena Springs) with gravel (pers. obs. Andy Gluesenkamp). Because springs form in erosional environments, material deposition is not beneficial to the water quality, water quantity, and persistence of aquatic organisms. Fine materials suspended in the water column increase the turbidity and decrease water quality. Features within the streambed become clogged with finer particles and limit the amount of water that recharges and emanates from the aquifer. Additionally, salamanders and other organisms can be directly impacted as the material is dumped into the spring; aquatic organisms at the deposition site are prevented from exploiting surfacewater habitats and food resources after the spring orifice is obstructed. Long-time Salado resident Mr. Chester Critchfield, for whom Critchfield Springs (one of the Salado Springs) was named, commented that when one of the springs in the series is clogged by debris or deposition of sediments, the others will produce more flow (C. Critchfield, pers. comm. to C. Norris, 2009). Mr. Critchfield reported that "cleaning" out the sediment and alluvial deposits from individual springs would decrease the flow of other springs and similarly, that deposition in one spring orifice results in the increased discharge of others.

Riparian zone management is also a concern in the Salado Creek watershed. Riparian habitats maintain healthy aquatic ecosystems by filtering sediments and pollutants from water, attenuating floodwaters, controlling erosion, and providing high quality fish and wildlife habitat. Impacts adversely affecting these habitats in the Salado watershed have been observed from livestock access to streams and spring sources, recreational activity, and land clearing activities to the stream edge. The riparian zone of Salado Creek within the Village of Salado (east of I-35) has been heavily altered and consists primarily of turf grass with few trees and understory present. The northern bank of the creek is lined with extensive cobble and gravel deposits. According to Mr. Critchfield, the riparian zone and islands within the channel have routinely been cleared of vegetation in the past. As a result, this section of the creek and the areas surrounding many of the springs are devoid of shading and are experiencing erosion problems, which contribute to poor water quality (temperature, turbidity, dissolved oxygen).

Existing Regulatory Mechanisms

Although the Salado salamander is globally and locally rare (G1/S1, NatureServe 2011), it is not currently listed as threatened or endangered by the State of Texas. This species' population security has largely depended on voluntary stewardship and management of surface and ground water resources. Management and use of groundwater and surface water (Texas Water Code) rules do not always consider the interconnectivity of these two resources. Water management is organized on political (counties) rather than ecological (watershed, aquifer, recharge zone) boundaries and not all

groundwater resources are covered by a managing entity. Pumping in part of an aquifer not under a managing entity is governed by the "rule of capture." Currently, the groundwater resources of Bell County, including the Northern Edwards (BFZ) Aquifer, are managed by the Clearwater Underground Water Conservation District. Currently, there are no Groundwater Conservation Districts (GCDs) in Williamson or northern Travis counties so pumping from the Northern Edwards (BFZ) Aquifer in these counties is unregulated.

In an effort to manage aquifers as a whole and promote coordination between GCDs, the Texas Legislature created 16 Groundwater Management Areas (GMAs) that were tasked with defining the Desired Future Conditions (DFCs) of their respective aquifers (House Bill 1763, 79th Legislature, 2005). The Northern Balcones Fault Zone (BFZ) Aquifer is one of many aquifers within Groundwater Management Area 8 (GMA 8), but is one of the few aquifers in the state with a DFC based on springflows. The desired future conditions set by GMA 8 for the northern segment of the Edwards (Balcones Fault Zone) Aquifer are as follows:

- Maintain at least 100 acre-feet per month (about 1.5 cfs) of stream/spring flow in Salado Creek during a repeat of the Drought of Record in Bell County.*
- Maintain at least 42 acre-feet per month (about 0.7 cfs) of aggregated stream/spring flow during a repeat of the Drought of Record in Travis County.*
- Maintain at least 60 acre-feet per month (about 1 cfs) of aggregated stream/spring flow during a repeat of the Drought of Record in Williamson County.*

The historical minimum reported discharge at Salado Springs is 4.6 cubic feet per second (Brune 1981), which is more than three times the minimum springflow designated for Salado Springs by GMA 8; however, it is unclear if the regulatory mechanisms exist to ensure the DFC of 100 acre-feet per month of springflow in Salado Creek can be maintained given that no GCDs exist in Williamson and northern Travis counties.

Special Management Considerations

In addition to protection of spring orifices, water quality and quantity of the recharge zone of the source aquifer is key. Limiting impervious cover, reducing the potential for hazardous spills and contaminants, improving land management practices over the recharge zone and adjacent to the spring and stream outflow areas could contribute beneficially to salamander conservation. Targeted use of existing and new landowner incentives and well-planned development can encourage riparian area best practices, conservation easements, appropriate types and density of new development; these are beneficial management considerations for spring-dependent species. Maps of significant faults that cross the bed of Salado Creek and contribute to recharge can be found in Dahl (1990) and Jones (2003). Groundwater in this segment of the aquifer typically travels from south to north; therefore, mapping faults with

respect to groundwater flow can help to pinpoint areas that are particularly important to maintaining groundwater quality and quantity for the Salado salamander.

Georgetown salamander (*Eurycea naufragia*)

Distribution, Abundance, and Density, including Survey Information

The Georgetown salamander (*Eurycea naufragia*) was described by Chippindale et al., (2000) and is known from springs and caves around the City of Georgetown in Williamson County (Figure 3). This species is known from 17 sites in the San Gabriel watershed although it may have been extirpated from one site (San Gabriel Springs). Despite repeated visits, no salamanders have been observed at this site in two decades (Chippindale et al. 2000).

The westernmost locality for this species, Water Tank Cave, has extensive stream passage populated by large, troglomorphic salamanders. A potential resurgence of the stream in Water Tank Cave is Cedar Hollow Spring, which is populated by typical surface form animals. A single troglomorphic individual was observed at Swinbank Spring (B. Pierce, pers. comm. to Andy Gluesenkamp, 2010) suggesting that this large spring may also be the resurgence of an extensive subterranean stream with a hypogean population of salamanders. No samples from troglomorphic specimens are available for genetic study at this time although it is likely that this morphology does not represent a separate taxon.

Most known populations of *E. naufragia* appear to be robust and salamanders are not uncommon at relatively undisturbed sites; however, detailed population studies have not been conducted at most sites. Pierce et al. (2010) studied microhabitat requirements and spatial distribution of *E. naufragia* within a single springflow. They found that surface abundance was highest during spring and summer and diminished with distance from the spring orifice.

Habitat Description and Requirements

The Georgetown salamander is found in springs and underground streams. Like other Texas *Eurycea*, it is intimately tied to groundwater and requires adequate quality and quantity for its survival. In addition, because most populations are associated with surface spring environments, intact aquatic plant and invertebrate communities are necessary to provide adequate foraging habitat and prey base for surface populations.

Threats and Issues

Issues affecting this salamander and its habitat include increased groundwater extraction, increased urbanization (i.e., impervious cover, wastewater, non-point source runoff) in recharge and contributing zones, runoff contamination and persistent hazardous organic compounds, and poor watershed management practices (i.e., disturbance of riparian zones, livestock impacts,

and gravel and limestone mining). See previous sections for descriptions of similar impacts and citations.

Degradation from decreased springflow, non-native species, and gravel deposition in the springs and stream over the past decades (P. Chippindale, pers. comm. to Andy Gluesenkamp, 2009) has been observed at the complex of springs in San Gabriel River Park (San Gabriel Springs). A large municipal well is located adjacent to the springs. This well is used primarily during summer months (when springs are typically at their lowest flow) to meet local demands. Flow from the springs is dramatically reduced when the well is in use (B. Pierce, pers. comm. to Andy Gluesenkamp, 2010). A deep bed of nonnative granite gravel covers the spring runs, which are largely devoid of aquatic plants. Hobby aquarium gravel has been observed in two of the spring runs suggesting that non-native aquatic organisms may have been released at this site. Destruction and modification of surface habitat and groundwater pumping on-site have likely resulted in the extirpation of salamanders from the springs.

Existing Regulatory Mechanisms

Despite the global and local rarity of this species (G1/S1, NatureServe, 2011), it is not listed as threatened or endangered by the State of Texas. Surface and groundwater management regulatory mechanisms also affect the status of this species.

Special Management Considerations

Conservation of this species is made more difficult by the extensive urbanization throughout much of its range. Conservation strategies are limited; the potential to set aside preserves and conservation banks are compromised by the lack of available suitable properties contributing watersheds of Williamson County.

Jollyville Plateau salamander (*Eurycea tonkawae*)

Distribution, abundance, and density, including survey information

The Jollyville Plateau salamander (*Eurycea tonkawae*) is known from springs and caves in northern Travis and southern Williamson counties (Chippindale et al., 2000). Surveys and mark-recapture (MRC) studies by City of Austin staff have provided much valuable information about this species (O'Donnell, et al. 2008). In addition to estimating population size at several sites, they have detected significant differences in trends of salamander counts between sites with low and high levels of impervious cover. Also, multi-year MRC studies have demonstrated that salamanders retreat to underground refugia when springs run dry. As a result, populations are not drastically affected by seasonal drought (Bendik, 2010).

Habitat Description and Requirements

This species is groundwater dependent although it can occupy a range of habitats associated with groundwater including: underground streams, springs, spring runs, and riffles in spring-fed creeks. As with other central Texas *Eurycea*, the quality and quantity of available groundwater are important to its survival. Bowles, et al. (2006) documented correlations between environmental conditions and salamander density and identified a negative correlation between urbanization and habitat quality.

Threats and Issues

Direct impacts on surface habitat and decreasing quality and quantity of groundwater are major threats to this species. Rapid population growth in Travis and Williamson counties is driving extensive urbanization of nearly the entire Jollyville Plateau salamander's range. Issues affecting this salamander and its habitat include increased groundwater extraction, increased urbanization (i.e., impervious cover, wastewater, non-point source runoff) in recharge and contributing zones, runoff contamination and persistent hazardous organic compounds, and poor watershed management practices (i.e., disturbance of riparian zones, livestock impacts, and gravel and limestone mining). See previous sections for descriptions of similar impacts and citations. A large-scale infrastructure project underway by the City of Austin, Water Treatment Plan #4 (WTP4), presents a potential threat to Jollyville Plateau salamander populations as the transmission main may intersect groundwater conduits, resulting in de-watering or contamination of springs in the Bull Creek watershed affecting habitats where this salamander is known to occur (Bennett 2011).

Existing Regulatory Mechanisms

Despite its global and local rarity (G1/S1), the Jollyville Plateau salamander is not currently listed as threatened or endangered by the State of Texas. Surface and groundwater management regulatory mechanisms also affect the status of this species.

Special Management Considerations

Recent genetic studies (Chippindale, 2010) revealed a divergence among populations resulting in two lineages. One lineage occurs in the Bull Creek, Walnut Creek, Shoal Creek, Brushy Creek, and South Brushy Creek drainages, and a second lineage occurs in the Buttercup Creek and northern Lake Travis drainages and may also include salamanders from Kretschmarr Salamander Cave and SAS Canyon Springs in the southeasternmost Lake Travis drainage.

Austin blind salamander (*Eurycea waterlooensis*)

Distribution, Abundance, and Density, including Survey Information

The Austin blind salamander is known only from the Barton Springs complex in Austin, Travis County. No population estimates are available at this time. Traditional methods of estimating population size (MRC) would require that ability to sample within the aquifer environment; however, genetic approaches can be applied to situations where only occasional individuals appear on the surface. To that end, tissue samples were recently collected from wild-caught *E. waterlooensis* housed in the City of Austin's captive breeding facility and population-level analyses are planned for the near future.

Habitat Description and Requirements

Although it is only known from specimens collected or observed in surface waters (spring pools), the morphology and phylogenetic placement of this species strongly suggest that it is an aquifer species rather than a surface or near-hypogean dweller and therefore likely occurs in subterranean habitat elsewhere in the Barton Springs segment of the Edwards Aquifer. However, sampling of wells in the Barton Springs segment has been limited and unproductive with respect to this species. Given that this species is hypogean and has only been observed infrequently, when individuals appear on the surface in spring pools, the specific habitat requirements of *E. waterlooensis* are unknown. However, groundwater quantity and quality are obvious determinants of habitat suitability.

Threats and Issues

This species faces the same threats as its sympatric congener, *E. sosorum*, including challenges to groundwater quality and quantity exacerbated by urbanization. An additional threat that may be more acutely felt by this species than its sympatric congener is potential movement of the "bad water" line on the eastern margin of the Barton Springs segment of the Edwards Aquifer. As groundwater levels decline, hydrostatic pressure is decreased and the likelihood of saline water encroachment increases (Pavlicek et al. 1987). The lowering of water quality due to saline encroachment has been documented for the Barton Springs segment of the Edwards Aquifer (Slade et al. 1986). Encroachment of saline water into the aquifer portion of the Barton Springs segment may reduce the total amount of habitat available to this species, decrease habitat (water) quality throughout its limited range, or impact prey species on which it depends.

Issues affecting this salamander and its habitat include increased groundwater extraction, increased urbanization (i.e., impervious cover, wastewater, non-point source runoff) in recharge and contributing zones, runoff contamination and persistent hazardous organic compounds, and poor watershed management practices (i.e., disturbance of riparian zones, floodway control and development).

Existing Regulatory Mechanisms

Although the Austin blind salamander is globally and locally rare (G1/S1, NatureServe 2011), it is not currently directly protected by state threatened or endangered species laws. This species' population security has largely depended on voluntary stewardship and management of water resources as well as groundwater rules imposed by the Edwards Aquifer Authority (and subsequently taken up by Texas Commission on Environmental Quality, Barton Springs Edwards Aquifer Conservation District, and a take permit for the Barton Springs salamander issued to the City of Austin by USFWS. Surface and groundwater management regulatory mechanisms also affect the status of this species.

Special Management Considerations

Recent genetic studies revealed evidence of possible gene flow between *E. waterlooensis* and *E. sosorum* (Chippindale, 2009). More research is needed on this issue as it may have implications on captive breeding strategies and approaches to maintaining genetic diversity in wild populations of both species.

Determinations of Critical Habitat

For the *Eurycea* species in this evaluation, any determination of Critical Habitat needs to include assessment, mapping, and connectivity of surface watersheds, recharge and spring expressions to protect and sustain high water quality and appropriate flow levels important to these species.

TPWD offers support to USFWS in this status review; however, we request that the USFWS remain sensitive to the role of private land stewardship in the region. In the case that USFWS proposes listing of this species, we respectfully request that TPWD, conservation and landowner organizations, and industry are all fully engaged in the development of future management actions such as Habitat Conservation Plans (HCPs), Safe Harbor Agreements (SHAs), and other recovery efforts.

Thank you for the opportunity to provide these comments.

Sincerely,

A handwritten signature in black ink, appearing to read "Carter Smith", written in a cursive style.

Carter Smith
Executive Director

CS:AG:mb

Attachment: *Eurycea* sp. Citations, Maps and Appendix A (spring descriptions)

Citations

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Attachment: *Eurycea* sp. Literature Cited, Maps, and Appendix A
for the letter to USFWS from TPWD, 13 October 2011

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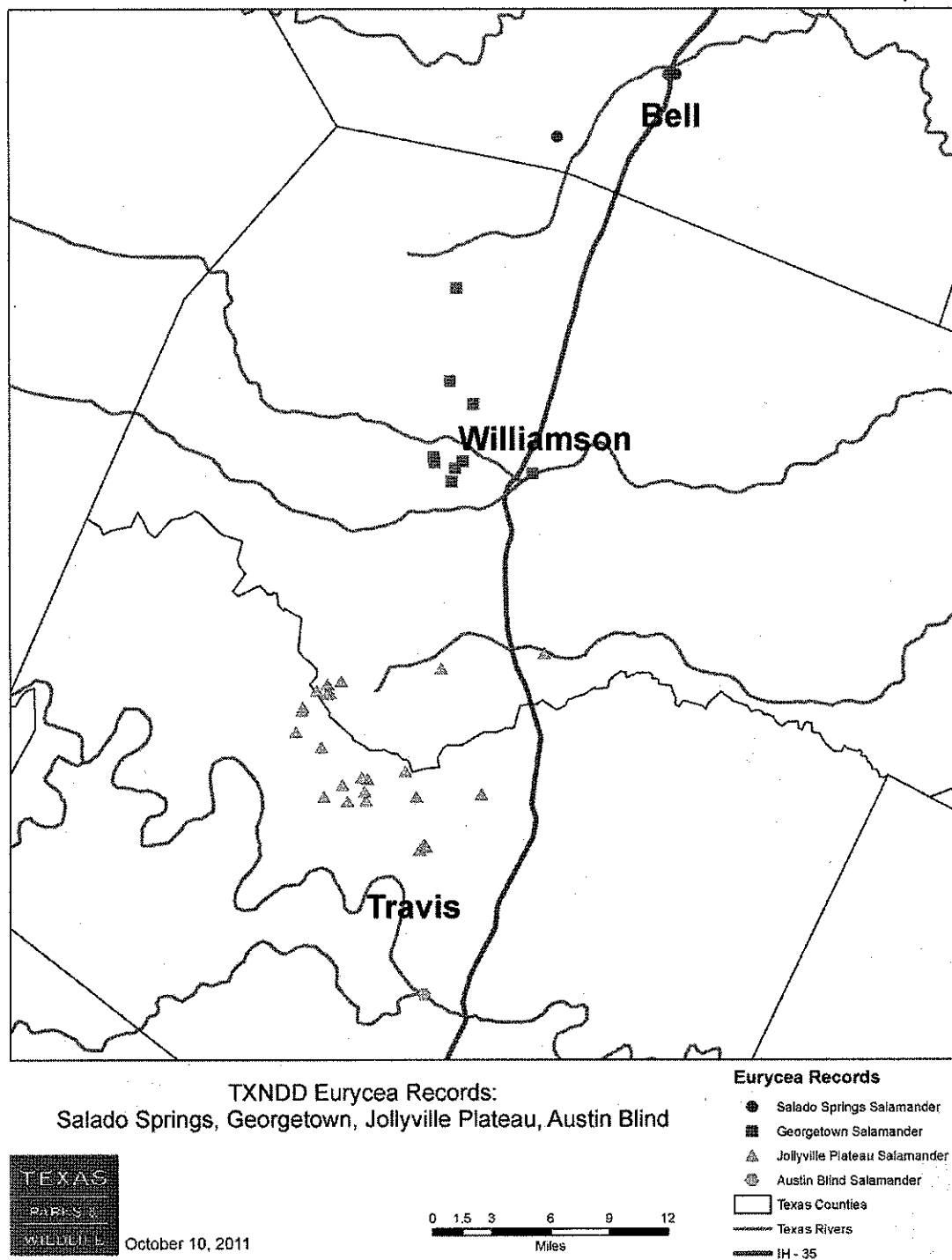


Figure 1. Distribution of four *Eurycea* species. Map shows TXNDD records only and may not reflect all known observations.

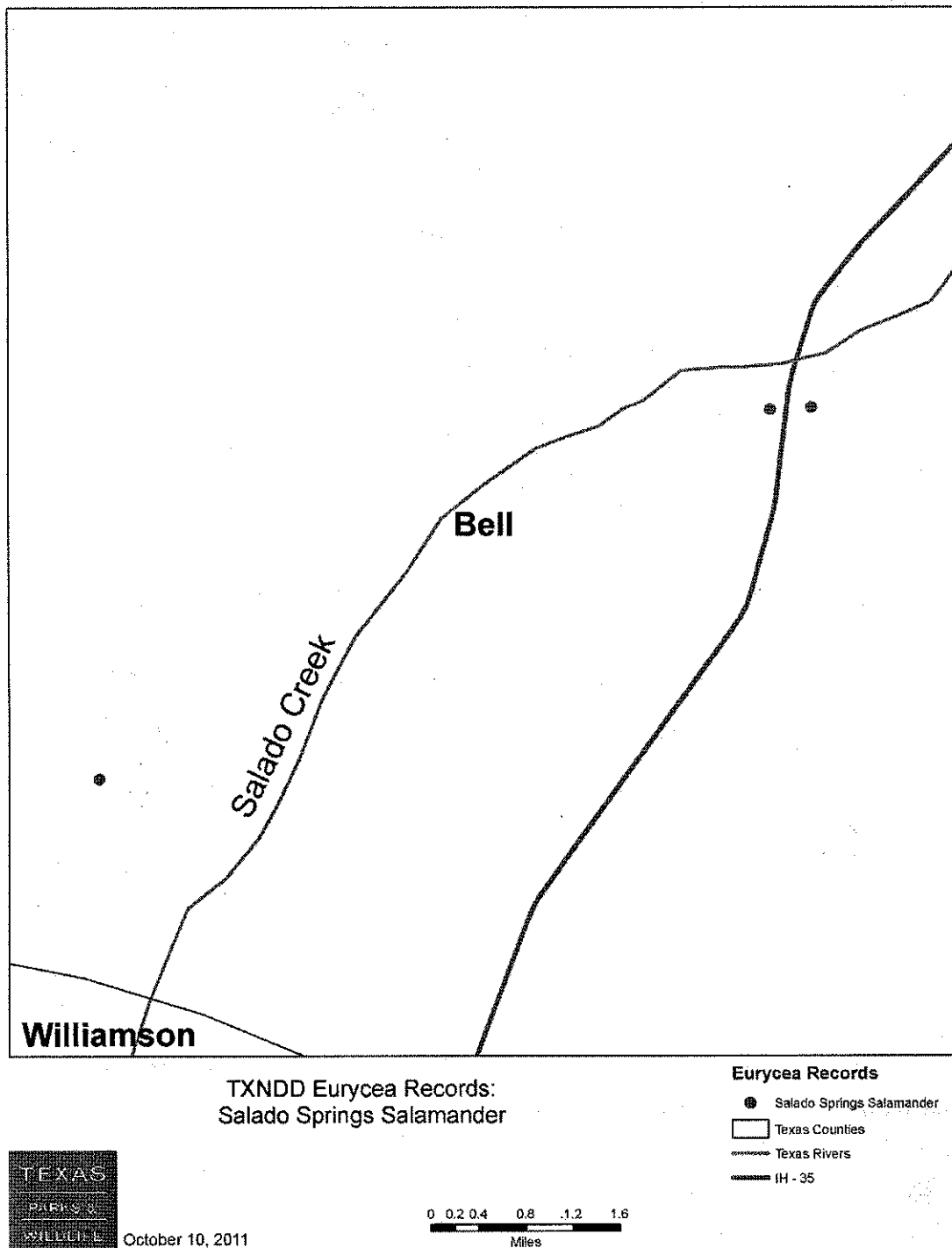


Figure 2. Distribution of *E. chisholmensis*. Upstream (westernmost) populations are shown as a single datum. Map shows TXNDD records only and may not reflect all known observations.

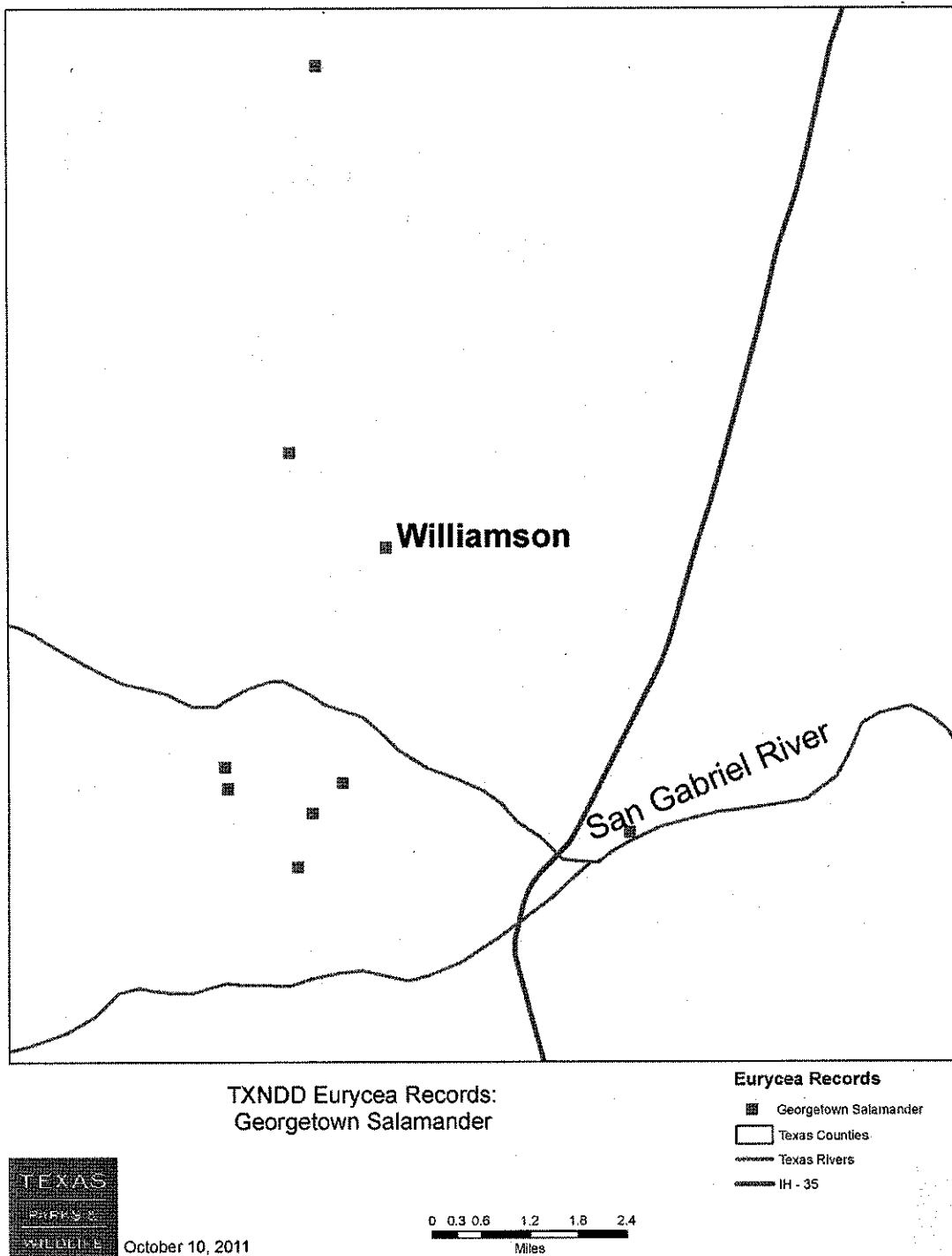


Figure 3. Distribution of *E. naufragia*. Map shows TXNDD records only and may not reflect all known observations.

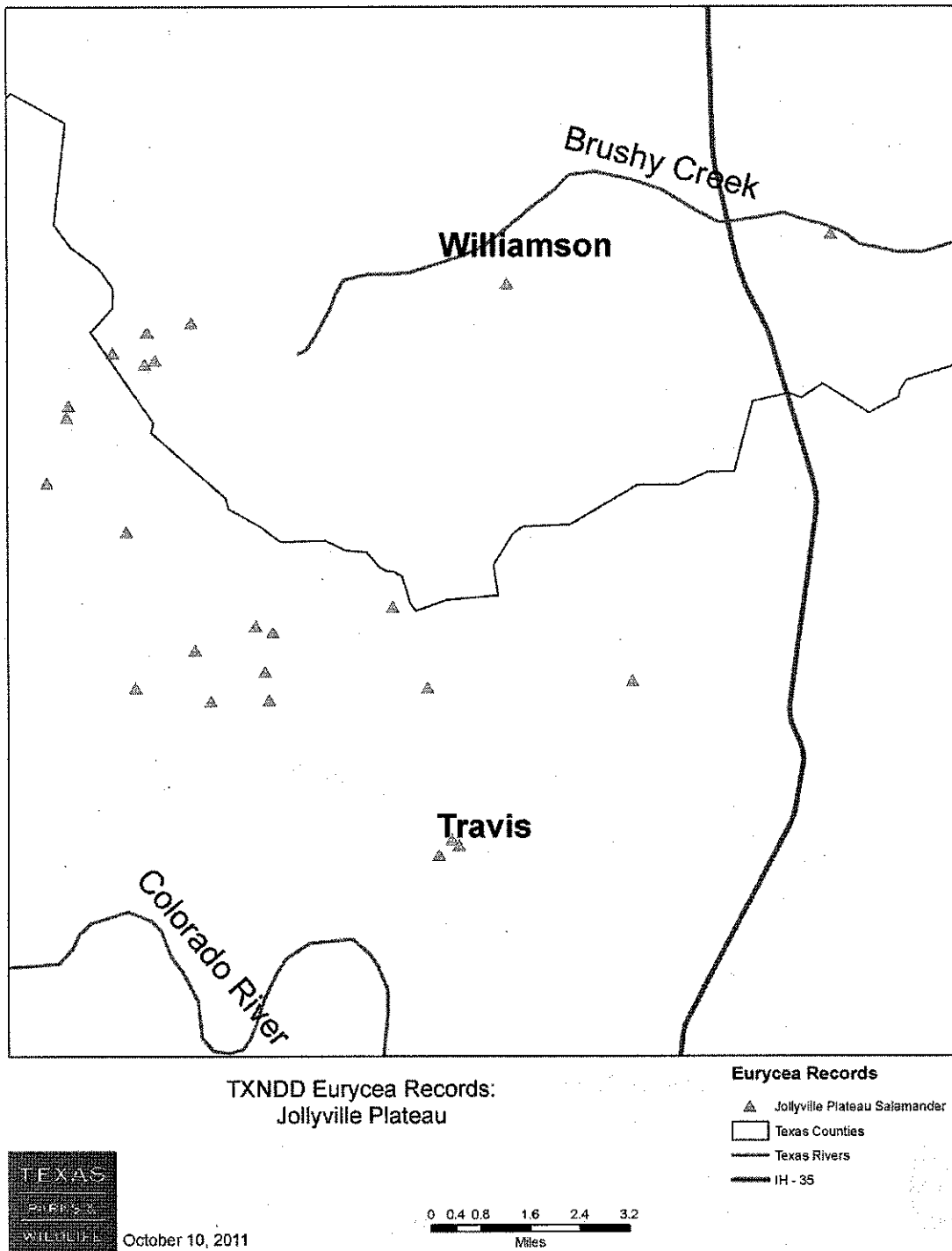


Figure 4. Distribution of *E. tonkawae*. Map shows TXNDD records only and may not reflect all known observations.

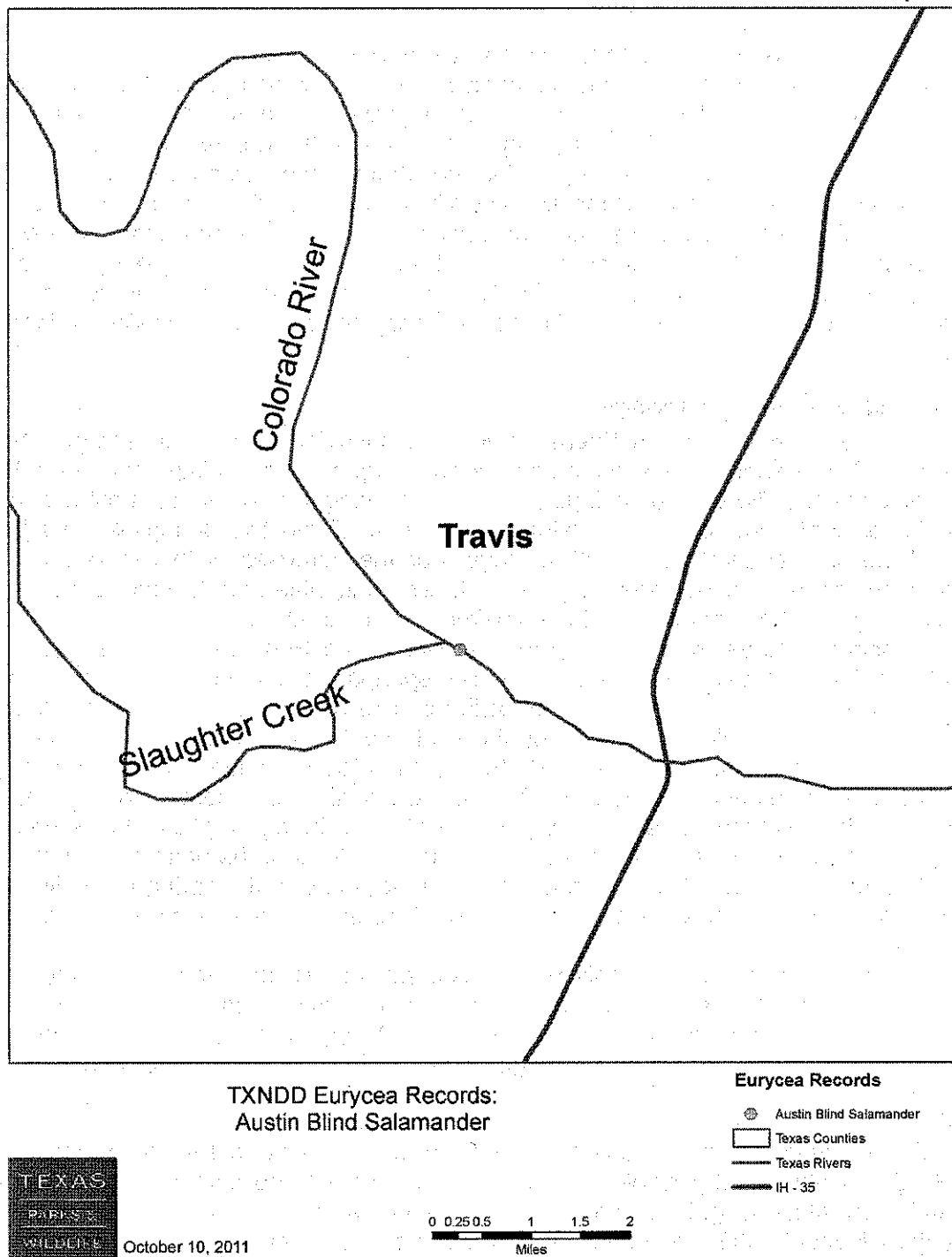


Figure 5. Distribution of *E. waterlooensis*.

Appendix A

Individual spring descriptions within the Salado Springs complex

Salado Springs is actually a series of springs that issue from faults associated with the Northern Segment of the Balcones Fault Zone. All of the Salado Springs issue from the southern bank of Salado Creek or within the creekbed as this represents the northern extent of the aquifer. The springs likely represent the initial discharge sites that drained the Edwards limestone prior to movement of the Balcones Faults Zone (Abbott 1975, Dahl 1990). As escarpments were formed along the Balcones Fault Zone, streams downcut and erosional processes exposed the Edwards Limestone, including its numerous vertical joints and historic discharge sites. The exposed vertical joints became paths for surface streamflow and rainfall to recharge the aquifer and groundwater movement was preferentially toward the sites that initially drained the limestone.

Big Boiling and Little Bubbly springs

Big Boiling Springs, also known as Sirena Springs, is considered the main spring orifice of Salado Springs. These springs once served as the water supply for the Village of Salado. Brune (1981) refers to the two Big Boiling Springs as reportedly rising in a fountain almost two meters high. Salado residents now commonly refer to the larger of the two springs as Big Boiling Springs and the smaller as Little Bubbly Springs. For the purposes of this report, we have chosen to recognize the springs separately as Big Boiling and Little Bubbly springs, but the two are described together here given their close proximity to one another.

Big Boiling Springs emerge from an enlarged fracture in the Edwards Limestone to form a shallow pool on the south bank of Salado Creek. The springs outflow through and over a gravel and cobble substrate about 15 feet before emptying into Salado Creek via a few small outlets (about 2 to 4 feet wide) in alluvial deposits on the south bank of the creek (or north end of the pool). A bronze statue of the Indian Mermaid Sirena sits atop a boulder within the spring-fed pool, which has stair-stepped limestone on its southern bank and a cement pad on its east bank. On the north end of the cement pad, the outflow of Little Bubbly empties into the pool.

Little Bubbly Springs emerge from at least two identifiable orifices at the head of a small spring run about 50 feet west of Big Boiling Springs. The southern end of the spring run is lined with limestone boulders and the channel contains abundant watercress over a substrate composed of gravel.

Surrounding Big Boiling and Little Bubbly Springs is a small public park that commonly attracts residents and tourists. The park is covered predominantly with turf grass and includes a few small (about 12-18 inches in diameter) trees with no understory present. The eastern boundary of the park is defined by an intermittent drainage, across which lies Critchfield Spring.

Critchfield Springs

Critchfield Springs were named for Chester Critchfield, who grew up in Temple, Texas north of Salado. Mr. Critchfield, an 83-year old resident of Salado, frequented Salado Springs as a child and his family ultimately bought the springs, to which their name was given, in 1959 and owned the property until about 2005. The springs reportedly supplied water for a boy's camp and even provided water for a swimming pool. The swimming pool has since been filled in and now lies beneath a large metal building. Subsequently, a bottled-water company obtained water from Critchfield Springs for years, but has since found other sources.

Critchfield Springs is composed of at least three identifiable spring outlets. One spring emerges from a small opening (about 3-4 inches in diameter) in alluvial deposits just downstream of a stone and cement footbridge within a small drainage. The other two springs emerge from the southern bank, just west of the drainage. The westernmost springs issue from cracks in stacked stones that line the perimeter of a steeply sloped and deeply entrenched pool. The pool is

adjacent to and downslope from an old stone building that is referred to as Mr. Terrel's Cabin. This pool outflows through a 3 or 4 inch PVC pipe into a broadened section of the drainage a short distance (about 20 feet) downstream of the aforementioned footbridge. The pool and upper portion of the channel contain abundant aquatic vegetation and a substrate predominantly composed of silt and sand.

The spring waters outflow from the northeastern portion of the widened channel into a relatively narrow (4-5 feet wide) spring run, which turns eastward, widens, and parallels Salado Creek. For further descriptive purposes, this channel is referred to as the Critchfield Spring Run. A small portion of the discharge from Critchfield Springs spills over a narrow (about 2-3 feet wide) spillway in a vegetated alluvial peninsula that separates the spring run from Salado Creek. However, the majority of discharge continues down the channel before being impounded by a small stone dam with an overflow notch in the middle. Additional springs issue just downstream of this small dam, including one that boils to the surface from a fracture that transects the spring run and Benedict Spring.

Benedict Spring

Benedict Spring is on the south bank of the Critchfield Spring Run as it parallels Salado Creek. The spring emerges from the base of a small cement bulkhead that is notched in the stream bank and was presumably constructed to protect the spring orifice from erosion. Habitat at the spring outlet is limited as the water quickly joins the Critchfield Spring Run. Additional springs adjacent to Benedict Springs were observed boiling from dissolution cavities in the bedrock substrate.

Anderson Spring

Anderson Spring emerges from an opening in the bedrock limestone substrate at the lower end of the Critchfield Spring Run. At the time of our visit, the springs produced a boil at the surface despite being covered by about three feet of water. The spring run upstream and downstream of Anderson Spring contained abundant filamentous algae and aquatic vegetation. The southern bank of the spring run adjacent to Anderson Spring was recently cleared of bamboo. About 20 feet downstream of the Anderson Spring orifice, water is impounded by a small stone dam. Downstream of the dam, water flows about 50 feet through abundant watercress (*Nasturtium* sp.) and pond weed (*Potamogeton* sp.) before joining Salado Creek.

Robertson Springs

Numerous springs issue from various openings, with some emerging from rather large (about 0.5 meters in diameter) openings and others from alluvial deposits. A majority of the springs are on the southern bank of the spring run channel, which trends in a northeasterly direction, but other springs issue within the channel, such as Colonel Robertson's bathtub. The larger spring orifices seemingly occur in the upper portion of the spring run with more alluvial springs in the lower portion, although small springs and alluvial springs occur along the spring run and from the alluvial peninsula that separates the spring run from Salado Creek.

Robertson Springs are reportedly the first group of Salado Springs to cease flowing during extreme drought. This is likely due to elevation differences between the spring orifices. As mentioned previously, the regional dip of the Northern Edwards Aquifer is to the east. Robertson Springs is the westernmost of the Salado Springs and lies at a higher elevation than Big Boiling Springs. During the drought of 2008-2009, Robertson Springs was reportedly reduced to a trickle of flow with only a small pool present at the main spring orifice. Robertson Springs is not flowing currently due to drought conditions.